STAR PANEL RECOMMENDATIONS FOR OFF-YEAR SCIENCE IMPROVEMENTS

General recommendations from recent (i.e., 2009, 2011, and 2013) stock assessment review (STAR) panels

- Apply other assessment methodologies, potentially including catch curves, surplus production models, stock reduction analysis, etc., to evaluate whether the information obtained on stock status, vital rates, and productivity are consistent with the assessment model.

- Conduct a formal review of all historical catch reconstructions and, if possible, stratify by month and area. The Scientific and Statistical Committee (SSC) recommended this be done after the Washington historical catch reconstruction effort is completed. The mixing of U.S. and Canadian catches is of particular concern for the Washington fleet. The accuracy and wide availability of consistent basic information is essential to the development of Pacific coast assessments. In addition to the raw data, the reliability and availability of more spatially dis-aggregated forms of the data should be investigated to determine if they could be used to develop more spatially or temporally explicit models without sacrificing accuracy.

- Discard estimates from the West Coast Groundfish Observer Program (WCGOP) should be presented, reviewed (similar to catch reconstructions), and be made available to the assessment process.

- Develop guidelines for use of the Lorenzen model for age-dependent natural mortality. The 2011 STAR panel investigated the use of age-dependent natural mortality (M) in both the Dover sole and sablefish assessments. In each case one of the reasons for exploring different mortality schedules was the potential imbalance between the genders in the age- and length composition information, either in the sex ratio at older ages (Dover sole) or in the ratio of young to old fish (Sablefish). The use of the Lorenzen M model, which is based on a decline in M with age by the inverse of the growth rate, implies a link with size-based predation. However, with likely wider use of this model feature there should be development of some guidance on the appropriateness of the implementation in other stock assessments.

- Conduct new studies of maturity by length and age based on more comprehensive coastwide and depth-based sampling and using histological techniques for determining maturity stage. Given that there is uncertainty regarding the temporal stability of maturity schedules, there should be periodic monitoring to explore for changes in maturity.

- Modify the Stock Synthesis (SS) code to allow changes to the plus-group age. The STAR panel found it very helpful to be able to modify the plus-group in the age-

composition data to investigate the influence of old versus young age composition data. This feature could also be used to explore the influence of ageing errors. The current version of SS requires restructuring of the input data if the plus-group is changed.

- Explore broader area assessments into Mexico and Canada for transboundary stocks.

- Exploring relative or absolute abundance of groundfish species in the Cowcod Conservation Areas (CCAs) is a key research priority. Submersible or other non-invasive survey methods could potentially provide additional information on habitat and abundance for these species. Also, it is important to develop alternative methods to monitor length and age compositions of fish inside the CCAs.

- A Management Strategy Evaluation (MSE) approach is needed to evaluate the 40-10 harvest control rule when applied to a stock with dramatically episodic recruitment, such as the Pacific hake stock. An MSE is also recommended to examine the likely performance of new flatfish control rules.

- SS3 implements new options for bias adjustment of stock recruit relationships that have been used with little or no peer review. Simulation testing is needed to confirm that bias adjustment is justified in all cases. Guidelines should be developed on how to configure bias adjustment settings to reflect the biological characteristics of the stock and the available assessment information.

- Develop methods to incorporate uncertainty in natural mortality and/or steepness in model configurations in which these parameters are fixed. The delta method for propagating uncertainty (McCall in prep.) is a promising approach that warrants further evaluation.

- Recommendations for a trawl survey workshop: Explore a Generalized Linear Mixed Method (GLMM) approach with a calendar date covariate to estimate catch per unit of effort (CPUE) indices for the entire triennial survey time series. A species assemblage meta-analysis approach could be used to develop priors for the ratios of catchability (q) among the early triennial, the late triennial, and the Northwest Fisheries Science Center (NWFSC) surveys. Consistent residual patterns in NWFSC surveys for a number of assessments suggests there may be some unknown factor affecting survey catchability, or that some factor is affecting the productivity of multiple stocks in the same way.

  From the 2013 data-moderate STAR panel: consider including a vessel factor (as a random effect) when developing indices for the triennial survey. Splitting the triennial survey into early and last periods became established practice without looking at the issue comprehensively or considering the loss of information from breaking a time series. A comprehensive evaluation of the issues and trade-offs is still needed. Consider developing generalized linear mixed model (GLMM) models in which latitude and depth are treated as continuous covariates rather than as factors.

  From the 2013 darkblotched/petrale STAR panel: Revisit the approach used to select

among error models and whether to include extreme catch event (ECE) components when conducting the GLMM analyses. For survey GLMM analyses, the stock assessment teams (STATs) need to report a standard summary of the raw data and fitting of the model including both results and diagnostics. Additional research should attempt to identify (and perhaps simulation test) a method for model selection including the error distribution, the treatment of random vs. fixed effects, and the inclusion of ECE mixture distributions that can be reliably applied across all species.

From the 2013 aurora/rougheye STAR panel: A workshop should be held to evaluate methods for constructing survey GLMM estimates. Topics that should be explored include: (a) the effect of treating vessels as random, when in fact the vessels hardly vary from one year to the next; (b) possible aliasing of the index values with the Vessel x Year interactions; and (c) the using information from the GLMM for combining length composition data collected by different vessels. One goal for the workshop should be to provide adequate documentation of the GLMM methods that will be used to produce survey biomass indices for future assessments.

- Explore the relationship between ageing precision, recruitment variability, and bias adjustment (and effects on depletion estimates) using simulation methods, and develop recommended procedures for appropriate methods to follow.

- Investigate alternative methods of re-weighting the data series in SS.

  From the 2013 aurora/rougheye STAR panel: A workshop should be held to evaluate methods (a) for the iterative reweighting of composition data (e.g., current approach based on SS3 calculation of effective sample size (effN) (versus the Francis approach) and (b) formulae for developing initial weightings (the initial input N values).

- More work is needed to better understand the performance of maximum likelihood and Bayesian estimators of stock size and trends when large numbers of poorly-informed recruitment deviations are estimated. Although it is logically appealing to include such uncertainty, even when there are little coherent data informing cohort strengths, technical and computational issues need to be solved before this approach can be implemented in situations such as yelloweye rockfish.

- Accessing and processing recreational intercept data from Recreational Fishery Information Network (RecFIN) and the three states is much too cumbersome for the Stock Assessment Teams (STATs). A single database that holds all the raw recreational data in a consistent format would greatly expedite processing and interpretation of the data, and would reduce the potential for introduction of errors.

- The 2013 data-moderate STAR panel strongly emphasizes the value of conducting a data workshop during which catches, indices, biology, and other data inputs are reviewed.

- The historical commercial passenger fishing vessel (CPFV) drift-specific data should be keypunched, which should allow the algorithm for developing CPFV-based data indices to be improved.

- Habitat maps should be developed so that structural rather than true zeros (e.g., absence of fish) are designated using data which are independent from the data used to determine the indices.

- Where possible, historical otolith samples aged using a combination of surface and break-and-burn methods should be re-aged using the break-and-burn method. Early surface read otoliths should also be re-aged using the break and burn method. Historical otoliths aged with a standard method will allow the further evaluation of the potential impacts of consistent under-aging using surface read methods, changes in selectivity during early periods without any composition information, and potential changes in growth.

- The effect of the implementation of the individual fishing quota catch shares program in 2011 on fleet behavior, including impacts on discards, fishery selectivity, and fishing locations, would benefit from further study.

- The extent of spatial and temporal variability on productivity processes such as growth, recruitment, and maturity is currently unknown and would benefit from further research.

- Investigate methods to include uncertainty in historical catches in the modeling.

- Maturity schedules are often largely determined by size and not age. An additional option is needed in SS to allow the modeling of maturity-at-length with an asymptote <1.0 to reflect atresia or skip-spawning.

- Age-at-maturity and other life history parameters are inherently uncertain for cowcod (and other species) and require further investigation. Future assessments should consider incorporating the uncertainty associated with age at 50 percent maturity.

- Priors to be used in extended depletion-based stock reduction analysis (XDB-SRA) models based on rockfish should be developed.

- Explore ways to index the abundance of sanddabs (and other nearshore species) in nearshore areas (i.e., waters shallower than 55 m) where the trawl surveys are not conducted.

<u>Recommendations for future data-moderate assessments</u>

- Nine stocks proved to be too many assessments to review at this STAR Panel. Reviewing a smaller number of assessments (4-8) may be a more feasible goal for STAR Panel review, depending on the level of pre-STAR panel review of data inputs. If area-specific models are considered in addition to coast-wide models, additional time or fewer stocks should be scheduled. However, the first time that any assessment method or stock

assessment is reviewed is always the most challenging, and future STAR Panels may find that the review goes much smoother.

- The STAR Panel recommends that data-moderate assessments continue to be reviewed at full STAR panels for at least the next assessment cycle. As methods become standardized and the review process becomes more routine, it should be anticipated that the review process can be streamlined somewhat.

- Objective criteria should be developed to specify minimum standards for model outputs to be considered "acceptable" and "preferred" and included in the Terms of Reference for stock assessments. Such criteria might include minimum goodness-of-fit criteria and acceptable limits on posterior distributions.

- While the STAR Panel made some progress in comparing XDB-SRA and extended simple stock synthesis (exSSS), our strategy of attempting to isolate the sources of difference between the two models ultimately proved unsuccessful, and resulted in complex requests to the STAT that were difficult to accomplish in the available time. The STAR Panel suggests that some of the model comparison work is more appropriate outside the STAR panel review process, particularly as it involves fundamental differences in how stock productivity is modeled.

- A standardized set of sensitivity runs, diagnostic plots, and performance statistics, such as runs tests on the residuals, should be developed to rapidly evaluate the performance of data-moderate assessments. Some pre-STAR panel planning involving the STAT and SSC to develop an analysis "package" could be helpful.

- As with any assessment and review process, there is a trade-off between the number of data-moderate assessments and quality of the assessment and review. This trade-off should be taken into account when planning for future STAR panel reviews of data-moderate assessments.

- The MSE should be further explored to evaluate the performance of exSSS and XDB-SRA. Other potential topics include error in the catch time series, uninformative indices of abundance, and time-varying productivity. The MSE could also be used to test whether more constrained models, such as fixing steepness or B_{MSY}/B_0, result in improved model performance.

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